MODIS Science Team Semi-Annual Report *

July-December, 1996

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Contract#: NAS5-31365

a) Task Objectives

During this phase of the project Dr. Eric Vermote formerly supported by this project became a MODIS Team Member. Dr Vermote was added to the team to augment the research and development of the surface reflectance product. In agreement with the MODIS Project Scientist, resources from this project will continue to support the surface reflectance / vegetation index / fire algorithm suite. This will include providing shared support for personnel and computer resources. In addition during this reporting period Dr Jeff Privette was hired by NASA. In agreement with Dr Darrel Williams (GSFC Code 923) Dr Privette will continue to work on coordination of the MODLAND Validation activity. Chris Justice joined the research faculty at UVa and continues to be an adjunct professor at UMd.

During this reporting period e continued to build the infrastructure and collaboration required to conduct the work of developing community consensus algorithms. The project has developed a number of collaborative projects that are intended to expand the scope of the team members' activities and involve a larger community in MODIS research. Due to the small number of researchers addressing the issues necessary for the methodological advances of MODIS, emphasis has been given to developing collaborative research and MODIS outreach through the IGBP Data and Information System Framework Activity and through participation in other instrument teams e.g. Eric Vermote in the POLDER, SPOT Vegetation and SeaWifs. Chris Justice also attended the discipline leaders meetings. The task of attending the weekly Technical Team (TT) Meetings is now shared with Dr Vermote.

In addition, the goals of the MODIS project, the status of the instrument and preliminary results of the research were presented at a number of key scientific meetings listed below. The project was also represented at the MODIS Science Team meeting. Results of the studies undertaken as parts of the project are in the process of being written up and submitted for publication. Publications are listed below.

b) Tasks Accomplished (Data analysis and interpretation)

Version 1 software (L.Giglio and P. Fisher)

During this reporting period, we focused on the completion and testing of the V1 code and the associated test data sets. This consisted of 1) rewriting portions of the code that needed corrections and/or reorganization to improve clarity and simplify processing, 2) identifying and optimizing computationally intensive tasks, and 3) incorporating new and/or replacement modules and functions into the Beta 3 code.

CIMEL Surface BRDF Measurements (w. J.Privette, E.Vermote)

As part of our efforts, the group continues to evaluate the potential of using a relatively inexpensive CIMEL sun photometer to measure bi-directional reflectance in the field. Initial testing was undertaken of an automated sampling protocol to collect data at 5° angular resolution over the full lower hemisphere. This protocol was coded onto an EPROM chip by CIMEL company personnel. Plans are being made to collocate the CIMEL next to the PARABOLA instrument (Don Deering, Code 923) as part of the MODIS Validation prototyping campaign in Jornada in May 1997.

Vegetation Index Compositing (w. A. Huete)

Work continues to develop the Level 3 compositing approach for the Vegetation Index. Discussions were held with Dr N. El Saleous of the AVHRR Pathfinder 2 program concerning the provision of data sets for some early prototyping of this product. The proposed MODIS algorithm is being applied as part of the Pathfinder 2 development.

MODIS Fire Detection (w. L. Giglio, P. Fisher, L. Flynn and Y. Kaufman)

The three objectives of this six month effort were to complete tests of the empirical relationship between fire and emitted energy, to determine the effects of the MODIS triangular response on fire pixels, and to assess whether the Volcano Alert algorithm codeveloped with the EOS Volcanology Interdisciplinary Science Team can be incorporated into the MODIS Fire Algorithm. Yoram Kaufman has derived an empirical relationship to calculate total emitted fire energy from the 3.95 μm MODIS data. Jackie Kendall incorporated this relationship into a working version of the MODIS code. Using the hypothetical MODIS fire scene of Yellowstone, we found 3145 fire pixels out of a total of 37800 pixels in the scene. Emitted energy characteristics of those pixels were found to be in agreement with a range of possible smoldering and flaming fire values. Other empirical formulas were tested that had limited success with either strong or weak fires, but not the entire range of fire intensities.

The MODIS triangular response is a result of the sensor viewing geometry. Essentially, the radiance detected by the sensor for a 1 km pixel has a 50% overlap with the two neighboring pixels in the cross-track direction. Thus, a 1-km pixel is actually sampling 2 km of ground at the nadir position beneath the MODIS instrument. The area sampled for off-nadir pixels will be affected by the viewing angle of the MODIS sensor. An algorithm has been developed where a TM scene having 30 m pixels is resampled to the 1 km MODIS spatial resolution using the MODIS triangular response. The algorithm will keep track of fire statistics such as the number of fires (at 30 m resolution) in a particular quadrant. Thus, we will be able to determine the relationship between flagged fire pixels and the fire position relative to the center of the pixel. We will also determine whether or not a single fire will be reported multiple times in neighboring pixels. If the number of fires occurring cross-track is 2 to 3 times higher than that occurring along-track, then we know that the MODIS triangular response will have a significant effect on results. To confirm this, we will then run the same data set through the MODIS triangular pixel algorithm but rotated 90° with respect to the first run. Essentially, the cross-track direction then becomes the along-track direction. The effects of the MODIS triangular response will be apparent if the results are greater for the cross-track direction in both cases. The next step will be to try to remove the effects of cross-track multiple reports of single fires, if it is a significant problem.

In addition, the Volcano Alert algorithm which has been developed by Luke Flynn through team member participation with the EOS Volcanology IDS Team marks an important step in the total assessment of global fires. The Volcano Alert will also be able to locate fires and is designed to report results on an updated Web page within a few hours of fire detection depending on how fast data are transferred from the receiving stations to Goddard. The current version of the algorithm works on nighttime data and will be part of the current MODIS Fire Algorithm. The Volcano Alert Algorithm has already undergone testing as the MOD_PRVOLC code and has passed all tests required by the MODIS TLCF. It is now being incorporated as part of the Level 1B - Level 2 processing effort. The Alert is important because it will provide a rapid first assessment for the MODIS Fire community. Data presented in the alert will be limited to fire location and an intensity indicator of the severity the fire or volcanic eruption. Note that the Volcano Alert Algorithm will NOT provide important information such as the fire emitted energy or relevant scene characteristics such as the amount of cloud-cover in the area. These functions will be performed and supplied by the "top" plane of the stored 8-day MODIS Fire Algorithm composites which have been designed as a quick-look summary of fire characteristics for a given area. It will contain much more detailed information than the Volcano Alert algorithm, such as actual image information to help with the location of fires, a simple cloud-cover summary, and the number of times that fires have been detected for a particular

pixel in the 8-day composite. The Volcano Alert algorithm currently operates on nighttime data only, but plans have been initiated to provide for a daytime alert algorithm which will essentially give two looks at the Earth per day.

Future work will include working on the daytime version of the Volcano Alert algorithm, creating MODIS-type data sets with SCAR-B data supplied by Rich Kleidman and finishing the MODIS triangular response study using TM data.

During this period the V1 Fire Code was delivered. Discussions were held with Dr Yoram Kaufman concerning the work assignments associated with the V2 Code Development. Design of the post-launch Fire Scar detection was initiated.A convergence of evidence approach is being adopted to provide a 10km, 8 day and monthly product. Attention will be given to the Channel 3 reflectance. A multi-author paper is being developed for submission in the Spring of 1997 describing the background to the fire algorithm and products.

The Fire ATBD was updated and posted to the EOS SPO Web Page. Written comments were received from three reviewers and have been included in the ATBD update. Justice and Giglio attended the IGBP Fire Algorithm Workshop at the IGBP DIS Office in Toulouse in October. Work continues to finalize the AVHRR Fire Algorithm which will provide a fire climatology to support post-launch product validation. A paper is being generated giving results of the AVHRR simulation /modeling study designed to evaluate the performance of the algorithm. In 1997 the model will be adapted for evaluating the MODIS algorithm.

Fisher and Giglio outlined the QA plans for the MODIS Fire Product.

EOS Validation (w. J. Privette)

The MODLAND Validation Overheads were updated and forwarded to the EOS Validation Office. The MODLAND ER 2 requirements were refined and submitted as part of the Validation Office Coordination Initiative. Plans were hatched for a Validation Prototyping Campaign in 1997, the objective being to develop the protocols for data collection commensurate with the MODIS spatial resolution. Discussions were held with MISR and ASTER scientists to participate in this prototyping activity. Two sites were identified and contacts were made with Site PI'.s Dr Privette joined Dr. Huete in a Validation Panning activity for the Southern Cone of South America in Chile. Dr Huete has spent much of the year on sabbatical in Chile.

The EDC DAAC Science Advisory Panel (w. Robert Wolfe SDST)

Chris Justice attended the EDC DAAC SAP meeting and represented MODIS concerns to the Land DAAC. He provided updates and commented on the MODIS ATBD review. The EOSDIS delivery slip

was discussed. Justice stressed the need for User Services to start building the knowledge base for Level 3 MODIS data distribution. Justice requested more emphasis from the DAAC on MODIS related issues such as ground control points, land sea mask and production planning. Justice agreed to chair the DAAC SAP for the period of one year prior to launch.

MODIS Early Science

Discussions were held with the AM Platform scientist on the need for an early science program, demonstrating the scientific advances resulting from the AM platform. A preliminary meeting was held at UVa with EOS IDS scientists and a group of interdisciplinary modellers to develop a science agenda for Southern Africa building on the results of the Trace A-SAFARI program. MODIS land products will be evaluated and used to achieve this early EOS science agenda. An outline of this research agenda was subsequently presented at NASA Headquarters to the R and A program management.

Meetings Attended

EDC DAAC SAP - Sioux Falls
EOS ATBD Review - GSFC
MODIS Team Meeting - GSFC
MODIS Land Cover Meeting - Boston
IGBP Fire Algorithm Workshop - Toulouse

New Publications

Kaufman, Y.J., C.O. Justice, L.P. Flynn, J.Kendall, E. Prins, D.E. Ward, A. Setzer, Monitoring Global Fires from EOS-MODIS, in preparation.

Giglio, L., J. Kendall and C.O. Justice, Evaluation of Global Fire Detection Algorithms Using Simualted AVHRR Data, in preparation.

New Staff

Paul Fisher (SSAI) - Code development / QA support
Anne Vermeulen (University of Maryland) - Anne will be supported by Eric Vermote starting first quarter 1997 to continue developing the radiative transfer component of the Surface Reflectance product. Bruno Margerin (University of Maryland) - System administration